Chemical Characteristics of Selected Rivers in Cumberland and Colchester Counties, Nova Scotia, 1984

D. Ashfield. D.K. MacPhail and G.J. Farmer

Enhancement, Culture and Anadromous
Fisheries Division
Biological Sciences
Department of Fisheries and Oceans
Halifax, Nova Scotia, B3J 2S7

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B3J 2S7

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ABSTRACT

Ashfield, D., D.K. MacPhail and G.J. Farmer. 1987. Chemical characteristics of selected rivers in Cumberland and Colchester counties, Nova Scotia, 1984. Can. Data Rep. Fish Aquat. Sci. No. 0646. v + 18 p.

Chemical characteristics of ten rivers located in Cumberland and Colchester counties, Nova Scotia, and draining to the upper Bay of Fundy, were measured on two occasions during 1984. Only limited information on the characteristics of these rivers previously existed and the results of this study can be examined to aid in determining their sensitivity to acidic precipitation. In this regard, a number of mainland Nova Scotia Atlantic coast rivers have become more acidic during at least the past 30 years, in response to increased acid loading by precipitation. Native salmon populations in some have become extinct. Salmon were angled in most of the ten study rivers during the 1982-84 period and total catch per year in these rivers represented from 7%-10% of the total recorded for Nova Scotia.

Key words: Atlantic salmon rivers, Cumberland County, Colchester County, Nova Scotia, water chemistry.

RÉSUMÉ

Ashfield, D., D.K. MacPhail and G.J. Farmer. 1987. Chemical characteristics of selected rivers in Cumberland and Colchester counties, Nova Scotia, 1984. Can. Data Rep. Fish. Aquat. Sci. No. 0646. v + 18 p.

On a mesuré à deux reprises en 1984 les caractéristiques chemiques de dix rivières situées dans les comtés de Cumberland et de Colchester (Nouvelle-Écosse) et se jetant dans la partie supérieure de la baie de Fundy. On ne disposait jusque-là que très peu d'information sur les caractéristiques de ces rivières. Les résultats de cette étude pourront aider à déterminer la sensibilité de ces cours d'eau aux précipitations acides. A cet égard, on a constaté que les rivières de la côte atlantique de la Nouvelle-Écosse continentale sont devenues plus acides au cours des trente dernières années à cause de l'acidité accrue des précipitaitons. Il en est résulté l'extinction des stocks indigènes de saumon. On a pratiqué la pêche du saumon dans la plupart de ces dix rivières entre 1982 et 1984 et les prises annuelles totales représentent de 7 à 10 p. 100 des prises totales enregistrées pour la Nouvelle-Écosse.

INTRODUCTION

A number of mainland Nova Scotia rivers which drain to the Atlantic coast have become more acidic during at least the past 30 years in response to increased acid loading by precipitation (Watt et al. 1983). The most seriously acidified rivers are those found on bedrock composed of granite and/or greywacke, and in some rivers, the native populations of Atlantic salmon have become extinct. Rivers which lie on slate have higher pH values, and the highest values are found for rivers which drain areas of carboniferous sediments. Watt et al. (1983) also demonstrated that the pH values of some rivers are inversely correlated with their rates of discharge, so that pH values are maximal during the late summer when discharge is lowest and minimal during the winter when discharge is usually greatest.

Previously, only limited information was available on the chemical characteristics of rivers located in Cumberland and Colchester counties, Nova Scotia, and draining to the upper Bay of Fundy (Cumberland Basin, Chignecto Bay, Minas Basin, Cobequid Bay). Thus, some of the chemical characteristics of ten of these rivers were measured in 1984 during a period of high discharge and during one of low discharge. Selection of the two sampling periods was made to gain insight into the existing ranges of pH and alkalinity. The major accessible tributaries of the ten rivers were sampled on both occasions to provide information on the chemical characteristics of the individual drainage areas.

Soils in a large portion of Cumberland and Colchester counties are classified as unsuitable for agriculture because of stoniness, acidity, and infertility (MacDougall and Nowland 1972). However, smaller areas possess soils which either support a wide variety of crops or are suitable for hay, grain and pasture. These soils and the sandstone which is found within the drainage of all ten rivers (Bujak and Donohoe 1980) provide some acid-neutralizing capacity to the rivers. This suggests that salmon populations in these rivers may not have been adversely affected by acidic precipitation. In this regard, salmon were angled in most of these rivers during the 1982-84 period (O'Neil and Bernard 1983; O'Neil et al. 1985; S.F. O'Neil, pers. comm.[1]).

MATERIALS AND METHODS

Several sites on the Chiganois, Debert, Folly, Great Village, Portapique, Bass, Economy, South Apple, East Apple, Hébert, and Maccan rivers were visited during July, August, and December of 1984 to obtain water samples. Samples were collected at each site in 500-mL polyethylene containers which had first been washed and then rinsed with deionized water. Samples taken for metal analyses were collected in 250-mL polyethylene containers which had been washed in a 50% HNO_3 solution and then rinsed with deionized water. Each sample for metal analysis was preserved by the addition of 1 mL of 50% HNO_3 solution. All chemical analyses of river water were performed upon return to the laboratory. A Metrohm Herisau pH meter was used to determine pH values for all sites within 24 hours of sampling. Total hardness, total alkalinity, chloride and sulfate were measured by using techniques outlined in Environment Canada (1981): total hardness as $CaCO_3$, by EDTA titration to Eriochrome Black T colour change; total alkalinity as $CaCO_3$, by potentiometric titration with H_2SO_4 to pH end points of 4.5 and 4.2; chloride, by the automated thiocyanate method; and sulfate, by titration with barium chloride, after adding thorin indicator. Specific conductance was determined at 25°C by use of a Metrohm Herisau conductivity metre and apparent colour was measured with a Helige Aqua Tester. Concentrations of calcium, magnesium and aluminum were determined by emission spectrophotometer (Jarrel-Ash, AtomComp).

Flow rates of the rivers included in the study were measured on December 11 and 12. For each river site, an Ott current metre (Model C-1) was used to measure water velocity at three equally spaced positions on a line delineating the width of the river. The propeller of the metre was adjusted at each position so that measurements were made at 0.6 of total depth. Flow rate was then estimated from the equation: $R=W \cdot D \cdot V$, where:

R = flow rate or volume
W = river width
D = river depth (average of 3 measurements)
V = water velocity (average of 3 measurements)

Flow rates of the rivers on the July 31 and August 1 sampling dates were estimated from their respective flows on December 11 and 12 and from the ratio of the flows recorded during the summer and winter sampling dates by Environment Canada (1985) at nearby stations 01DL001 (Kelly River) and 01DN004 (Wallace River). The ratio determined at station 01DL001 was used to estimate flows on July 31 for the South and East Apple, Hébert, and Maccan rivers while the ratio at station 01DN004 allowed estimates of the August 1 flows of the Chiganois, Debert, Folly, Great Village, Portapique, Bass, and Economy rivers.

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[1] O'Neil, S.F., Department of Fisheries and Oceans, P.O. Box 550, Halifax, Nova Scotia, B3J 2S7.

the cover artwork. K.E.H. Smith reviewed the manuscript and provided editorial comments.

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TABLE 1. Some chemical characteristics of Chiganois River system during August and December, 1984.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
August 1 (flow[1] - 0.519 m^3/s)											
A1	Above Staples Brook	6.99	16.1	20.1	71	5	5.7	0.8	6.9	4.3	390
A2	Staples Brook	6.88	20.3	23.3	78	5					
A3	Lightbody Brook	8.40	56.0	55.9	140	15					
December 12 (flow - 9.505 m^3/s)											
A1	Above Staples Brook	6.31	3.2	10.2	39	30	3.1	0.7	4.7	4.3	140
A2	Staples Brook	6.27	3.4	11.3	45	40					
A3	Lightbody Brook	6.84	16.1	25.2	77	60					

1. Estimated.

TABLE 2. Some chemical characteristics of Debert River system during August and December, 1984.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
August 1 (flow[1] - 0.517 m^3/s)											
B1	Above head of tide	7.25	23.0	28.9	191	5	9.4	1.1	7.4	4.8	360
B2	Pine Brook	7.85	40.0	44.9	132	10					
B3	Totten Brook	6.92	7.2	10.2	38	15					
December 12 (flow - 9.457 m^3/s)											
B1	Above head of tide	6.49	4.2	11.0	40	25	3.3	0.7	4.3	3.8	120
B2	Pine Brook	6.51	5.1	12.4	43	30					
B3	Totten Brook	5.87	1.6	8.9	34	40					

1. Estimated.

TABLE 3. Some chemical characteristics of Folly River system during August and December, 1984.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
August 1 (flow[1] - 0.534 m^3/s)											
C1	Above head of tide	8.15	35.7	42.1	142	5	13.9	1.2	15.9	4.9	360
C2	McElman Brook	7.65	32.1	32.9	108	5					
C3	Folly River, below Folly Lake	6.61	6.0	12.7	81	15					
C4	East Branch Folly River	6.72	4.9	8.3	33	15					
December 12 (flow - 0.768 m^3/s)											
C1	Above head of tide	6.55	5.0	12.2	47	25	3.5	0.8	7.3	4.4	100
C2	McElman Brook	6.10	2.2	7.8	44	15					
C3	Folly River, below Folly Lake	6.44	5.0	13.1	49	30					
C4	East Branch Folly River	5.75	0.6	6.9	29	25					

1. Estimated.

TABLE 4. Some chemical characteristics of Great Village River system during August and December, 1984.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
August 1 (flow[1] - 0.489 m^3/s)											
D1	Above head of tide	7.98	44.6	47.8	152	10	15.9	1.8	12.2	7.5	360
D2	Rockland Brook	7.50	15.5	30.9	112	5					
D3	Great Village River, above Rockland Brook	7.33	19.4	28.4	91	10					
December 12 (flow - 8.943 m^3/s)											
D1	Above head of tide	6.78	7.2	14.1	48	15	4.2	0.9	4.9	4.9	60
D2	Rockland Brook	6.10	1.7	7.8	32	15					
D3	Great Village River, above Rockland Brook	6.39	3.0	9.3	35	15					

1. Estimated.

TABLE 5. Some chemical characteristics of Portapique River system during August and December, 1

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
August 1 (flow[1] - 0.500 m^3/s)											
E1	Above head of tide	7.12	18.5	21.1	71	5	5.7	1.0	4.2	5.4	370
E2	Crowe Brook	7.73	41.7	40.2	106	10					
E3	Portapique River, above Crowe Brook	7.30	12.3	19.0	62	5					
E4	Cook Brook	7.37	28.5	38.7	104	15					
December 12 (flow - 9.144 m^3/s)											
E1	Above head of tide	6.52	5.0	11.3	40	25	3.5	0.8	3.6	4.3	80
E2	Crowe Brook	6.60	8.2	16.5	52	40					
E3	Portapique River, above Crowe Brook	6.48	4.3	10.0	36	15					
E4	Cook Brook	6.39	5.1	14.0	48	40					

1. Estimated.

TABLE 6. Some chemical characteristics of Bass River system during August and December, 1984.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
August 1 (flow[1] - 0.146 m^3/s)											
F1	Above head of tide	7.08	8.6	14.2	53	10	3.7	0.8	4.2	6.6	380
F2	West Bass River	7.59	38.2	58.8	32	10					
December 12 (flow - 2.681 m^3/s)											
F1	Above head of tide	6.32	5.0	9.9	36	25	2.9	0.7	3.6	4.6	120
F2	West Bass River	6.43	5.5	12.4	45	40					

1. Estimated.

TABLE 7. Some chemical characteristics of Economy River system during August and December, 1984.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
August 1 (flow[1] - 0.588 m^3/s)											
G1	Above head of tide	7.12	12.5	15.0	55	15	3.9	1.1	4.4	4.6	390
G2	East Economy River	6.75	10.8	12.3	49	10					
December 12 (flow - 9.801 m^3/s)											
G1	Above head of tide	5.98	1.5	8.0	32	45	2.3	0.7	3.3	4.0	210
G2	East Economy River	6.15	2.6	9.1	36	45					

1. Estimated.

TABLE 8. Some chemical characteristics of South Apple River system during July and December, 1984.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
July 31 (flow[1] - 1.643 m^3/s)											
H1	Above head of tide	6.00	1.4	5.4	38	25	0.9	0.6	6.4	4.2	440
December 11 (flow - 6.163 m^3/s)											
H1	Above head of tide	5.18	<0.5	10.1	50	110	2.2	1.4	7.1	4.2	480

1. Estimated.

TABLE 9. Some chemical characteristics of East Apple River system during July and December, 1984.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
July 31 (flow[1] - 1.703 m^3/s)											
J1	Above head of tide	6.10	1.1	5.4	32	30	1.0	0.6	4.6	3.6	460
December 11 (flow - 6.385 m^3/s)											
J1	Above head of tide	5.09	<0.5	8.8	41	110	2.0	1.1	5.0	5.0	440

1. Estimated.

TABLE 10. Some chemical characteristics of River Hébert system during July and December, 1984.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
July 31 (flow[1] - 1.127 m^3/s)											
K1	Above head of tide	6.64	7.8	8.3	38	55	2.0	0.7	6.4	3.0	410
K2	Kelley River	6.54	3.4	3.9	40	65					
K3	Atkinson River	6.65	4.9	5.4	29	35					
K4	River Hebert, below Newville Lake	6.51	6.9	7.6	38	55					
December 11 (flow - 4.227 m^3/s)											
K1	Above head of tide	6.40	4.9	8.8	41	25	2.4	0.8	6.9	3.0	40
K2	Kelley River	5.70	1.0	4.8	26	50					
K3	Atkinson River	5.88	1.3	5.9	27	55					
K4	River Hebert, below Newville Lake	6.42	4.5	9.2	45	25					

1. Estimated.

TABLE 11. Some chemical characteristics of Maccan River system during July and December, 1984.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
July 31 (flow[1] - 2.954 m^3/s)											
L1	Above head of tide	7.15	13.3	16.7	67	15	3.8	1.2	6.7	5.22	430
L2	Little Forks River	7.00	15.7	18.1	99	15					
L3	East Branch Southampton River	7.35	33.2	47.0	212	30					
L4	Maccan River at Southampton	7.00	11.4	15.2	60	15					
L5	West Brook	6.85	9.5	13.2	51	10					
L6	Southampton River above West Brook	7.08	9.6	11.6	47	10					
December 11 (flow - 11.08 m^3/s)											
L1	Above head of tide	6.70	8.9	16.1	66	20	4.5	1.4	9.2	7.4	70
L2	Little Forks River	6.40	5.2	11.3	68	25					
L3	East Branch Southampton River	6.73	13.8	30.2	132	55					
L4	Maccan River at Southampton	6.60	8.5	17.1	74	20					
L5	West Brook	6.40	5.0	10.3	43	20					
L6	Southampton River above West Brook	6.58	6.3	11.1	49	15					

1. Estimated.

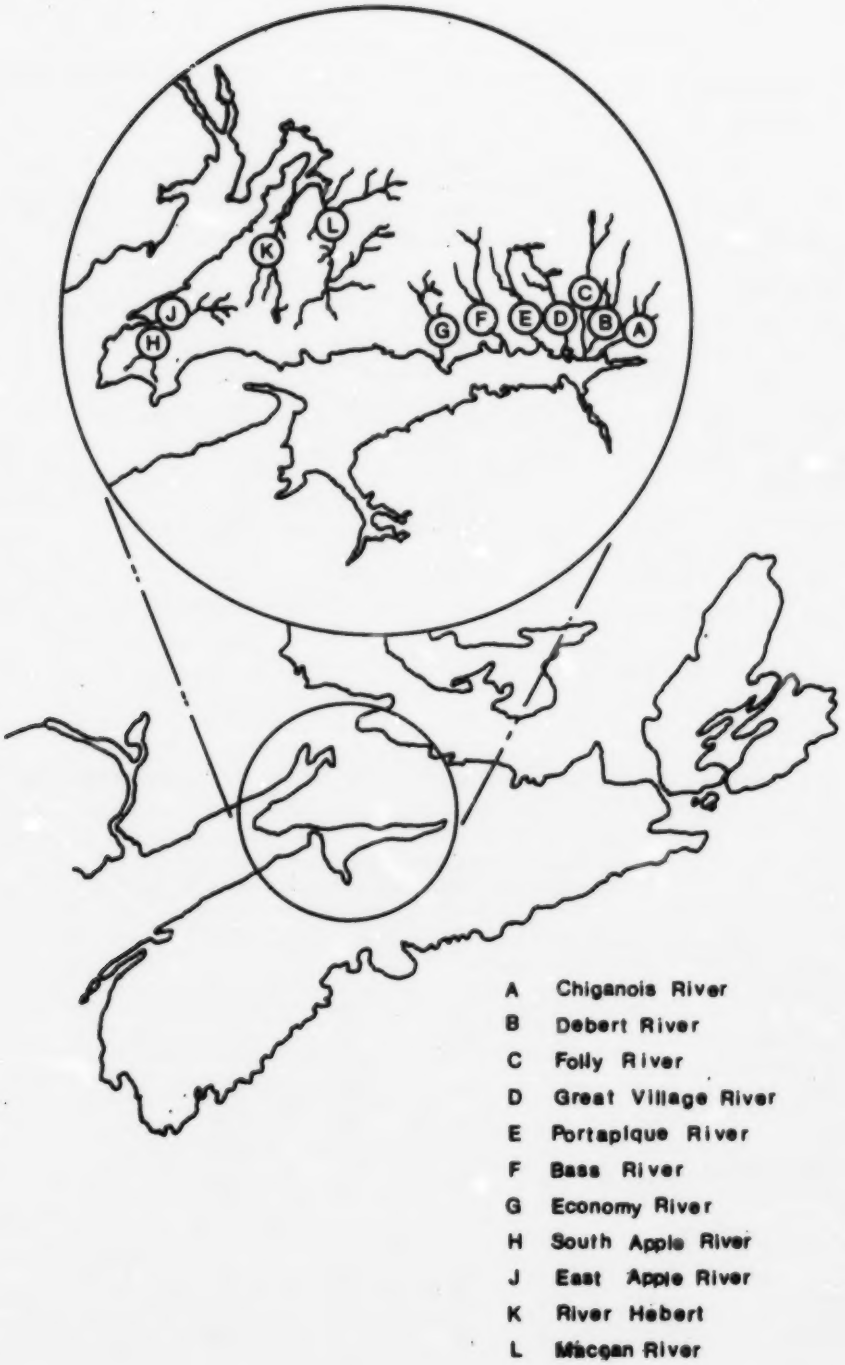

FIG. 1. Location of rivers included in the sampling program.

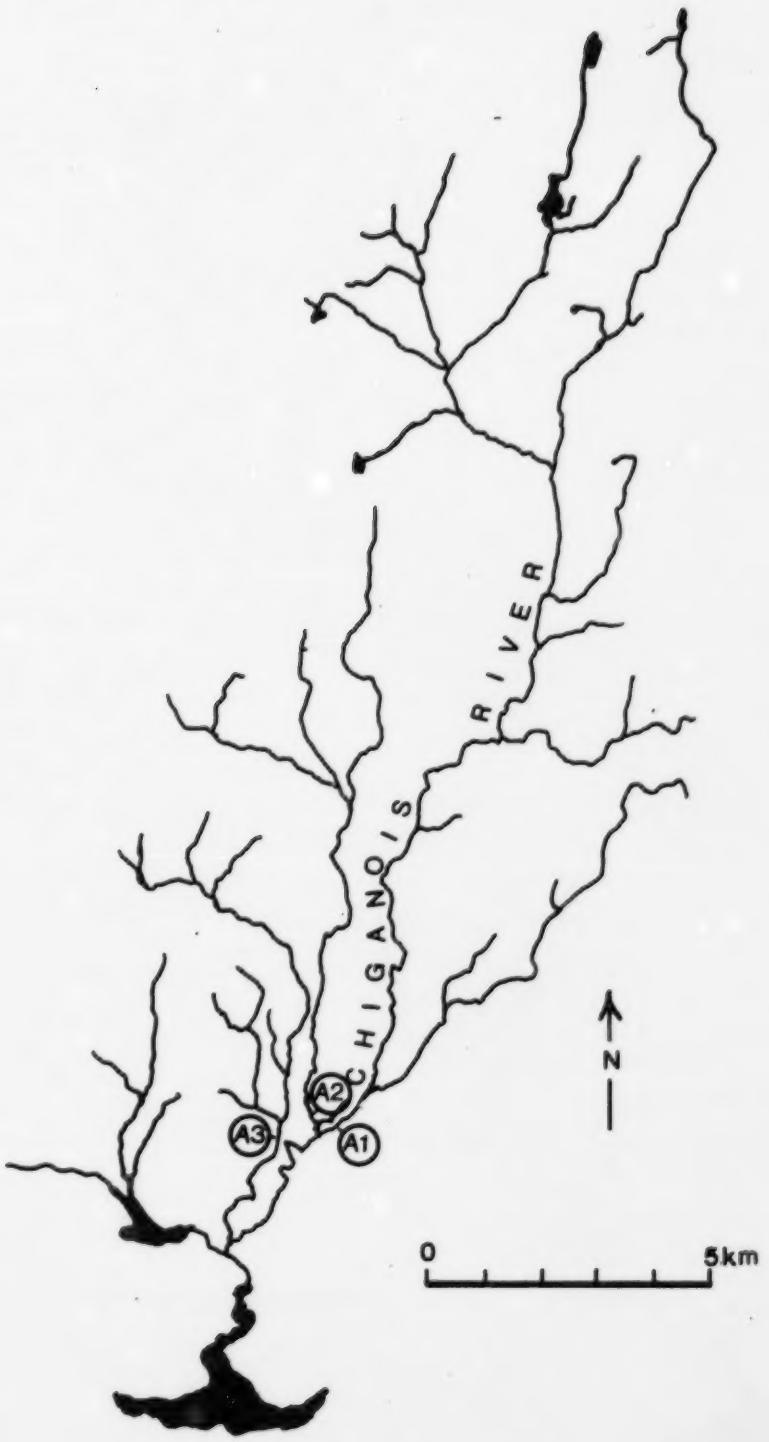

FIG. 2. Water sampling sites on Chiganois River.

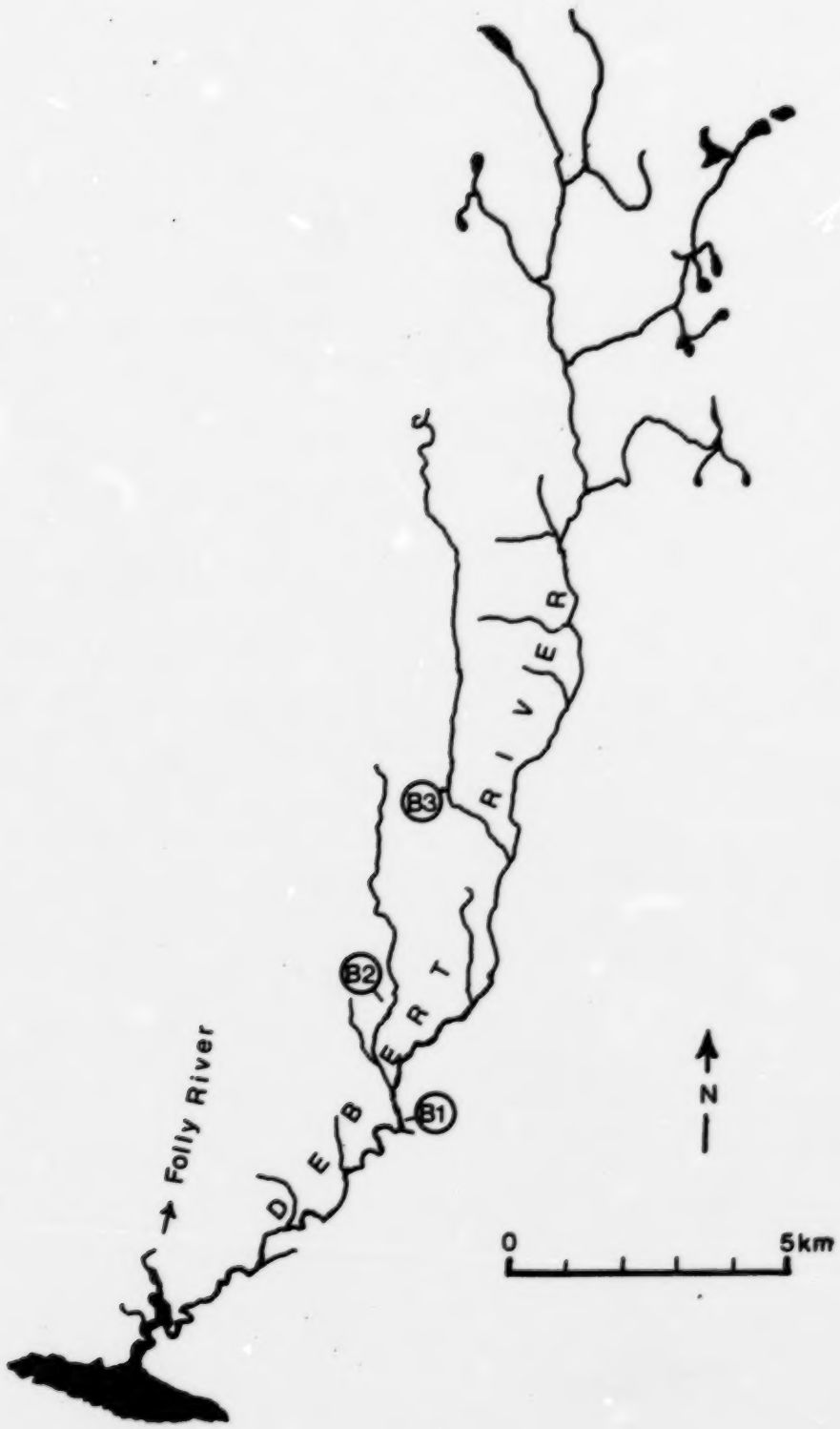

FIG. 3. Water sampling sites on Debert River.

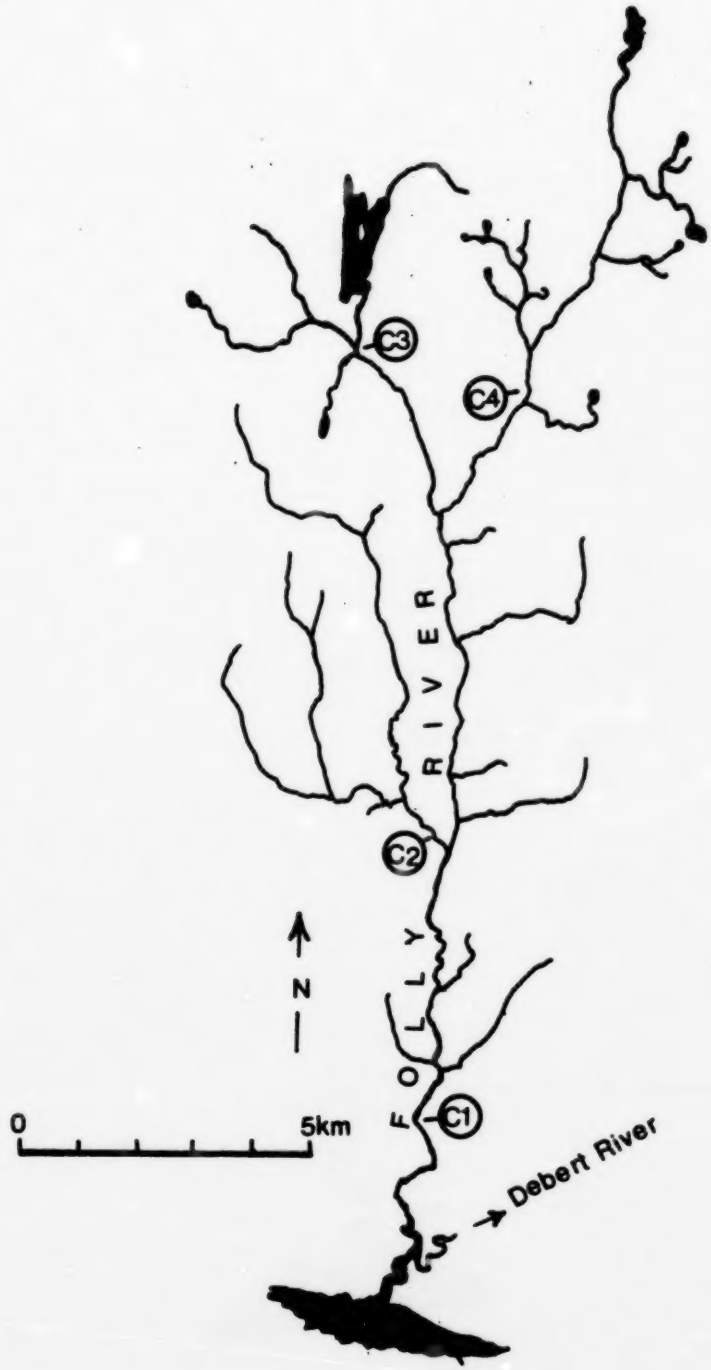

FIG. 4. Water sampling sites on Folly River.

FIG. 5. Water sampling sites on Great Village River.

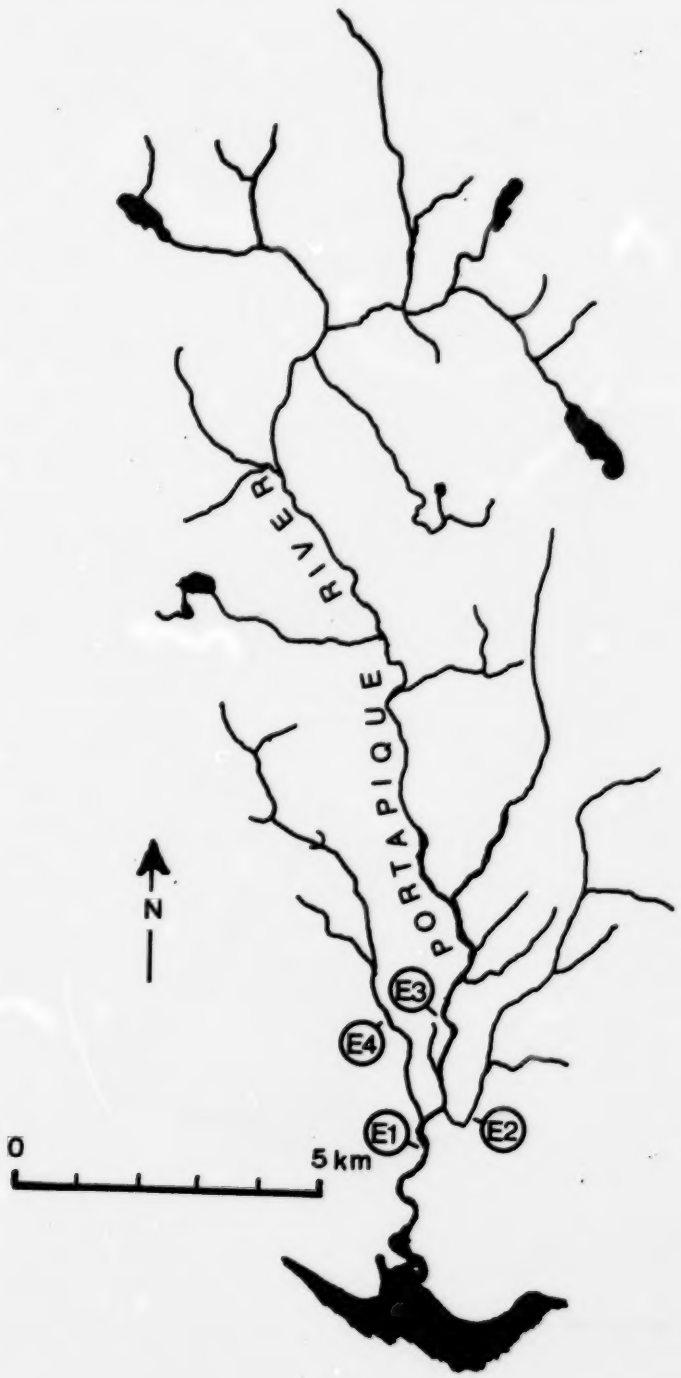

FIG. 6. Water sampling sites on Portapique River.

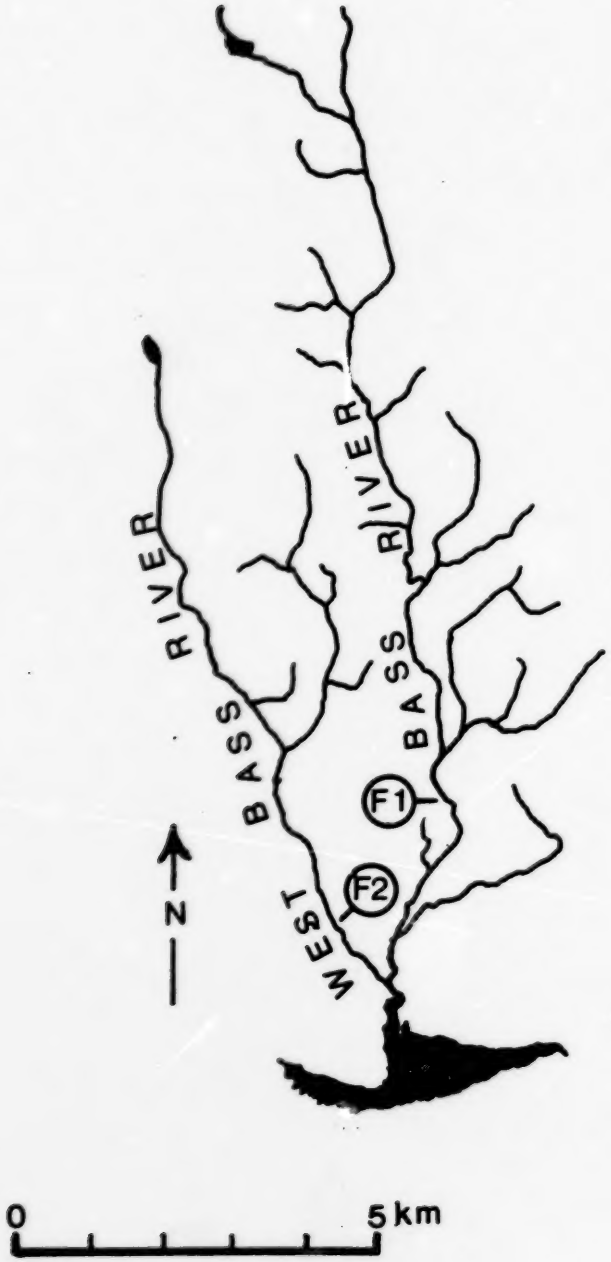

FIG. 7. Water sampling sites on Bass River.

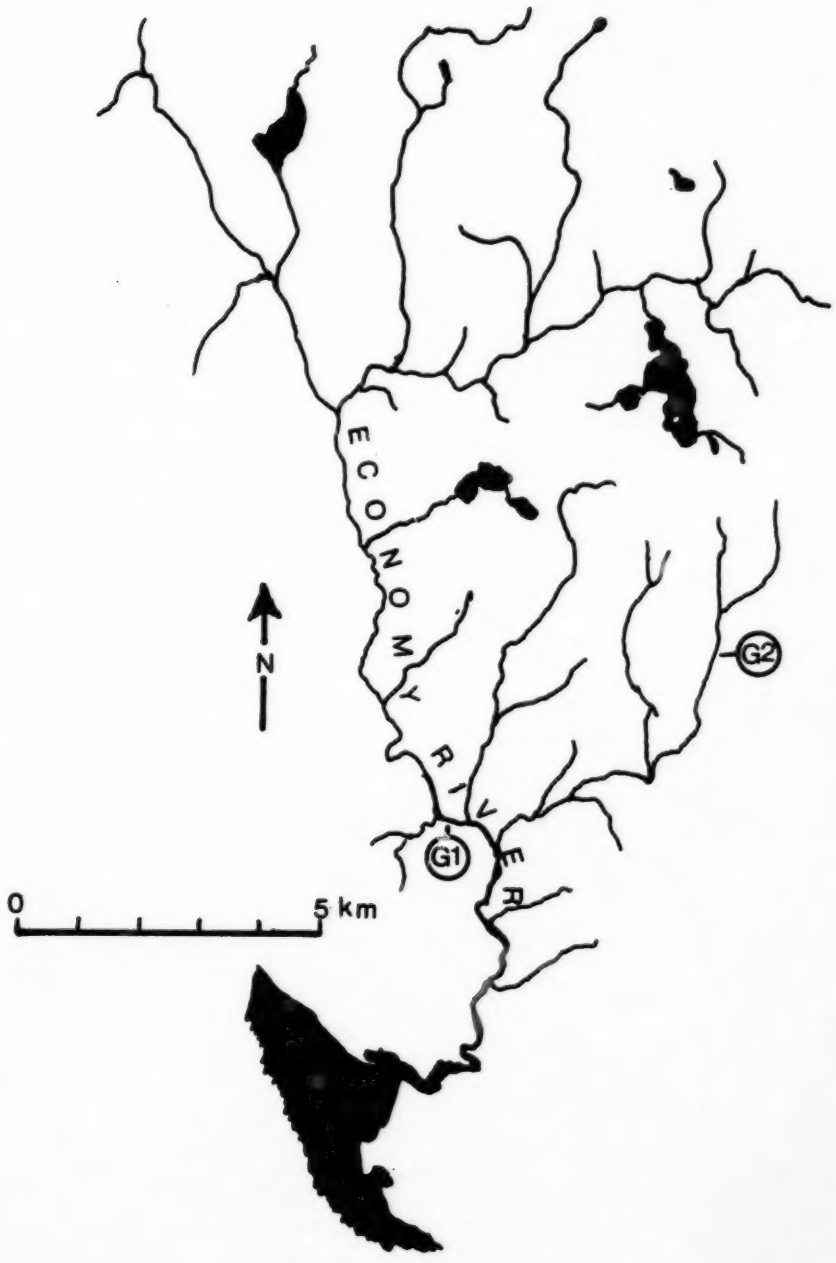

FIG. 8. Water sampling sites on Economy River.

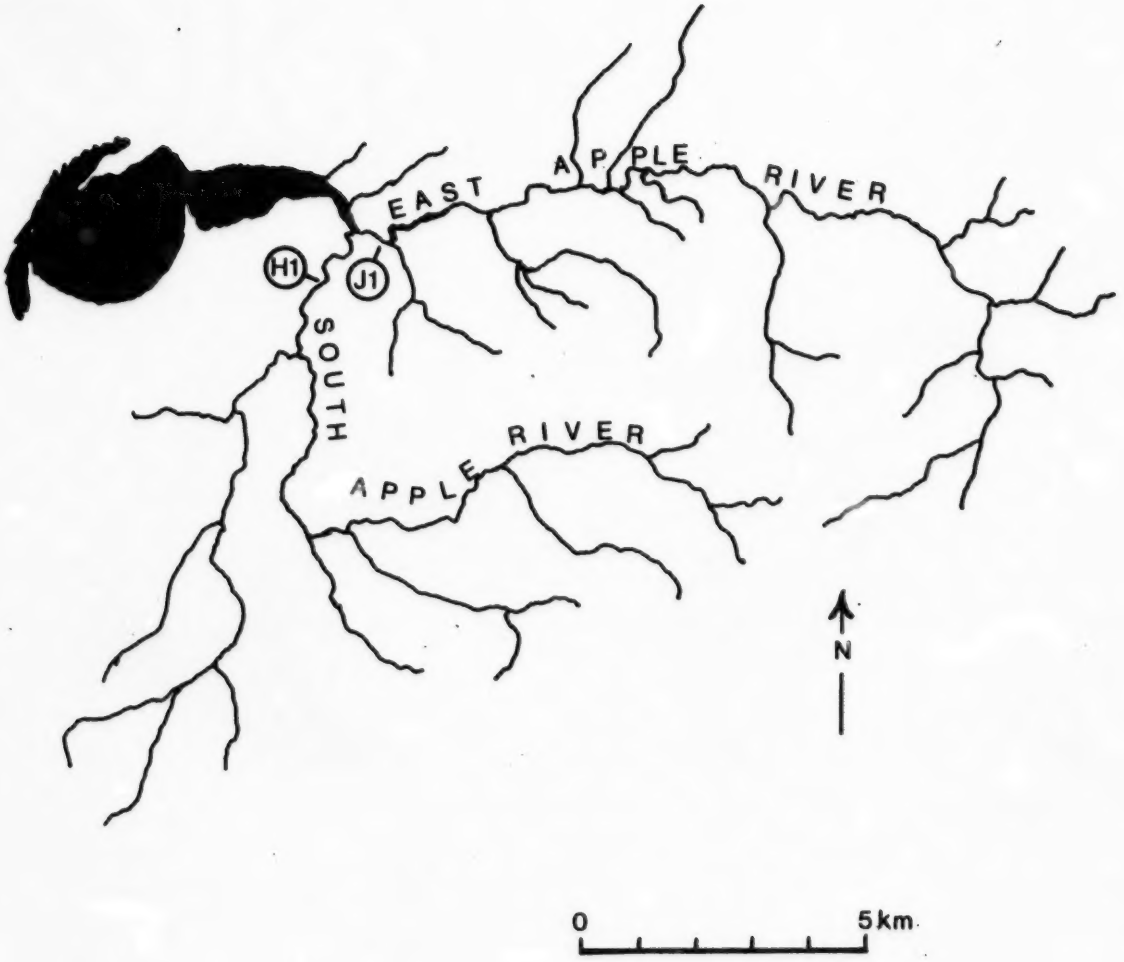

FIG. 9. Water sampling sites on South and East Apple rivers.

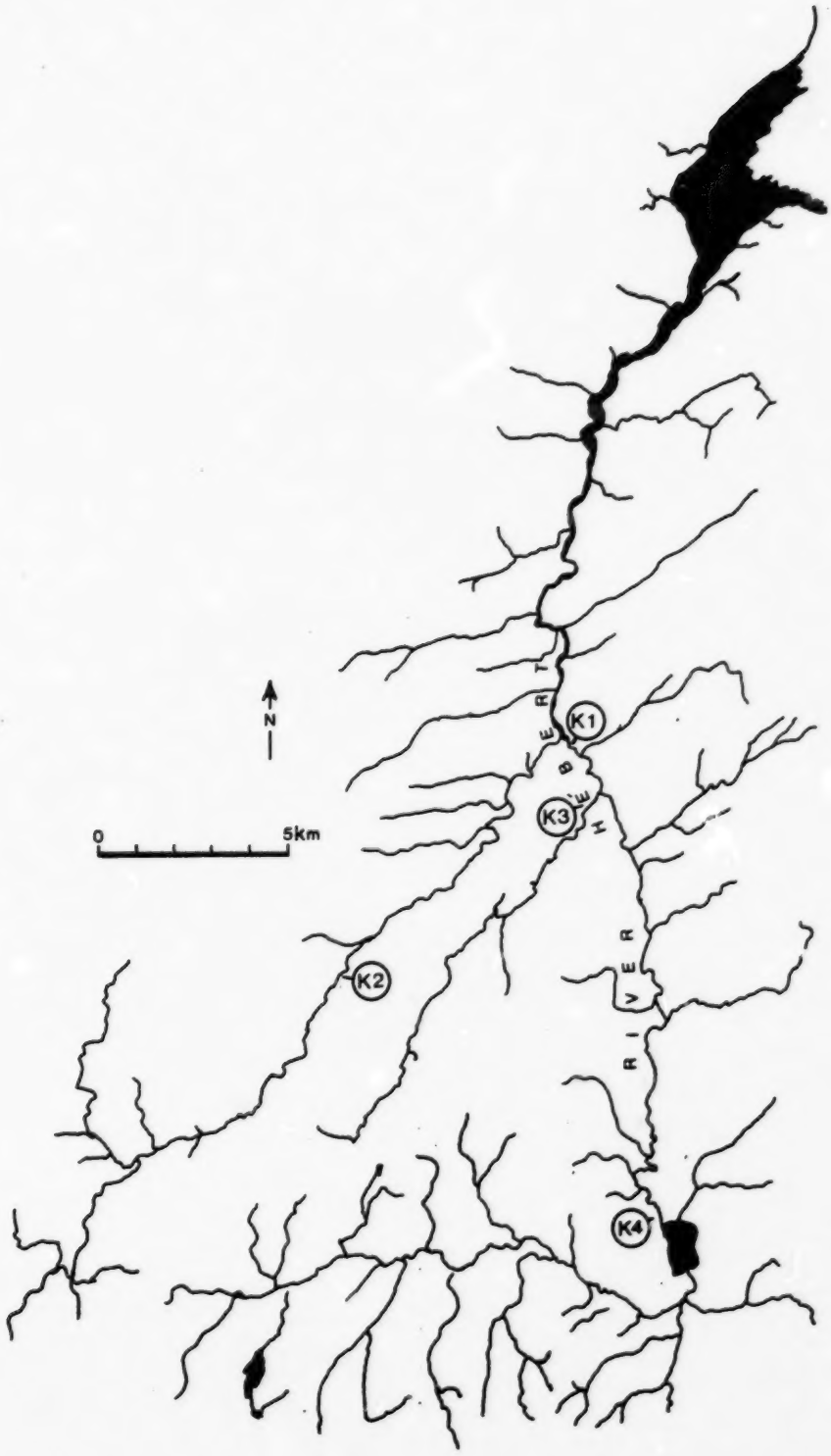

FIG. 10. Water sampling sites on River Hebert.

FIG. 11. Water sampling sites on Maccan River.